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National Policies for the Conservation and Management of *Melanosuchus niger* in Brazil: Species status & monitoring, research and current regulations

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CONTENTS

TECHNICAL RESPONSIBILITY AND CONTACTS

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ABSTRACT

After years of protection, natural populations of black caimans (*Melanosuchus niger*) in Brazil have increased steadily. In 2003, the species was removed from the official Brazilian list of endangered species. More recently, based on a number of more comprehensive biological studies which indicated that the species has large and not fragmented wild populations and is widely distributed within its range, *M.miger* was downlisted to CITES Appendix II (CoP 14). The present report describes some of the main outcomes achieved by the Brazilian Government, in collaboration with universities, research institutes and non-government initiatives in order to develop science-based conservation programs to promote the sustainable use of caiman products and to provide economic benefits for local Amazonian communities. Firstly, biological data obtained systematically in three strategic localities within the Brazilian Amazon are presented. This is followed by a brief description on the evolution of *M. niger* management program in the Brazilian Amazon, which includes the forms of management and the development of current legislation. Finally, the perspectives and main constraints affecting the program development are discussed.

1. Introduction

1.1. Conceptual background

The idea of conservation through sustainable use has been recognized as an important strategy to encourage the conservation of natural habitats and the preservation of biological diversity (IUCN/UNEP/WWF 1980; IUCN/UNEP/WWF 1991, Grigg *et al.* 1995). Accordingly, wildlife management systems are conceived as part of a global policy for sustainable development, which considers environmental conservation as a component of socioeconomic development. The underlying idea is that resources which bring tangible benefits to the people will have higher chances to be properly managed and conserved, in contrast to those not valued, which are more likely to give way to other uses for the lands.

The Programme for Conservation Biology and Management of Brazilian Crocodilians, which is developed by the National Centre for Research and Conservation of Reptiles and Amphibians (RAN/ICMBio), is a research and development (R&D) program, based on the concept of conservation through sustainable use, and current policies are oriented to organizing and developing the different segments of the value chain. The R&D approach provides an integrate view of the whole system and accounts for a number of articulated actions aiming at the sustainable use and responsible trade of caimans. Briefly, these include i) to establish preserves and sustainable use reserves in order to better protect caiman species and people traditional knowledge and culture; ii) to implement a set of standard field technics to monitor population status and habitats; iii) to improve primary and secondary processing and manufacturing facilities and iv) to develop communication and marketing strategies. Transversely to each segment of the value chain, research and training and dialogue with stakeholders play a vital role in generating solutions which, jointly with wise enforcement, is expected to foster the program development and ensure its success.

1.2. Political and socioeconomic background

The development of sound economical incentives to implement new means of production aiming at achieving rural socioeconomic development through a habitat conservation perspective is one of the main goals of a broader conservation program for the Amazon.

Caiman management, as a component of Amazonian sociobiodiversity, has an important role in promoting economical incentive to maintain natural ecosystems, if the principles of

sustainable use and responsible trade are applied properly. Integrating ecology and socioeconomic from a R&D perspective make the caimans an ideal model to implement current concepts on wildlife management as a mechanism of habitat conservation and social development.

1.3. Biological background

The black caiman (*Melanosuchus niger*) is widely distributed in the Amazon River Basin. Its distribution range includes Bolivia, Brazil, which accounts for approximately 80% of the species distribution range, Colombia, Ecuador, French Guiana, Guyana, Peru and Suriname (Figure 1).

Figure 1. Distribution range of black caiman, *Melanosuchus niger,* in South-America (yellow area on Bolivia, Brazil, Colombia, Ecuador, French Guiana, Guyana, Peru and Suriname).

From 1950 to 1970, natural stocks of black caimans were severely depleted because of overhunting. With the advent of CITES, the species was included in the Appendix I of the convention and, in 1982, it was listed in the first official Brazilian list of endangered species. After years of protection, in 2003, the list was revised by Brazilian specialists who, based on data on the actual densities confirming that black caiman populations had increased steadily, decided to remove the species from the official Brazilian red list. More recently, based on a number of more comprehensive biological studies

which indicated that the species has large and not fragmented wild populations and is widely distributed within its range (Brazil 2007), *Melanosuchus niger* was downlisted to CITES Appendix II (CoP 14). In fact, there are reports of high black caiman abundance at several Brazilian municipalities. In some cases, where abundances are extremely high, Federal and States Governments have been asked by local communities to take measures to reduce population size because of conflicts with humans. Males black caimans protect their territory and can become very aggressive, representing serious concerns for local communities. Several cases of black caiman attacks against local people have been reported. In first trimester of 2010, two accidents with humans have already been noticed, one was fatal and the other caused severe injury to the victim.

The present report describes some of the main outcomes achieved by the Brazilian Government, in collaboration with universities, research institutes and non government initiatives in order to develop sound, science-based conservation programs to promote the sustainable use of caiman products and to provide economic benefits for local Amazonian communities. Firstly, biological data obtained systematically in three strategic localities within the Brazilian Amazon are presented. This is followed by a brief description on the evolution of *M. niger* management in the Brazilian Amazon, which includes the forms of management and the development of current legislation. Finally, the perspectives and main constraints affecting the program development are discussed.

2. Monitoring natural genetic stocks of *Melanosuchus niger* in Brazil: recent research advances in biology and population dynamics

Systematic monitoring of natural population of caimans applying standard methodologies has been carried out in three strategic localities, representing distinct river basins within the Brazilian Amazon. These are i) Lake Cuniã Extractive Reserve (Cuniã Resex), located in the state of Rondônia, at the upper Madeira river basin, ii) the Area of Environmental Protection (AEP) Meandros do Araguaia, located in the state of Goiás, at the Araguaia river basin, which accounts for the southern limit of the species distribution range and iii) Mamirauá Sustainable Development Reserve (SDR), located in the state of Amazon, at the Solimões river basin, a core area of the species range (Figure 2). Following, a summary of the data obtained in each respective site is presented.

2.1. Lake Cuniã Extractive Reserve

2.1.1. Preamble

Resex Lake Cuniã, with an area of 55,850 ha, is located at Porto Velho municipality, to the left side of the low Madeira river, in the state of Rondônia. Adjacent to the area, there is another conservation unit, Cuniã Ecological Station, with 53,221 ha. Together, both units form a mosaic of around 109 thousands ha of protected forested area. The region is drained by a number of rivers and creeks (igarapés) and presents more than 60 perennial lakes, which maintain the rich Amazonian biodiversity. Among the most conspicuous vertebrate species, two crocodilians, *Melanosuchus niger* and *Caiman crocodilus*, are widely distributed in the area.

About 60 families, divided in four local communities, live in the area. During the last years, as the result of formal protection policies, a consistent growth of caiman numbers has been reported by local communities. They argue that the high caiman densities represent risks and affect their daily activities, as noted by a number of undesirable encounters with humans registered in the area. In 2004, there was a fatal accident, when a five yrs old child was killed by a 3.50 m black caiman.

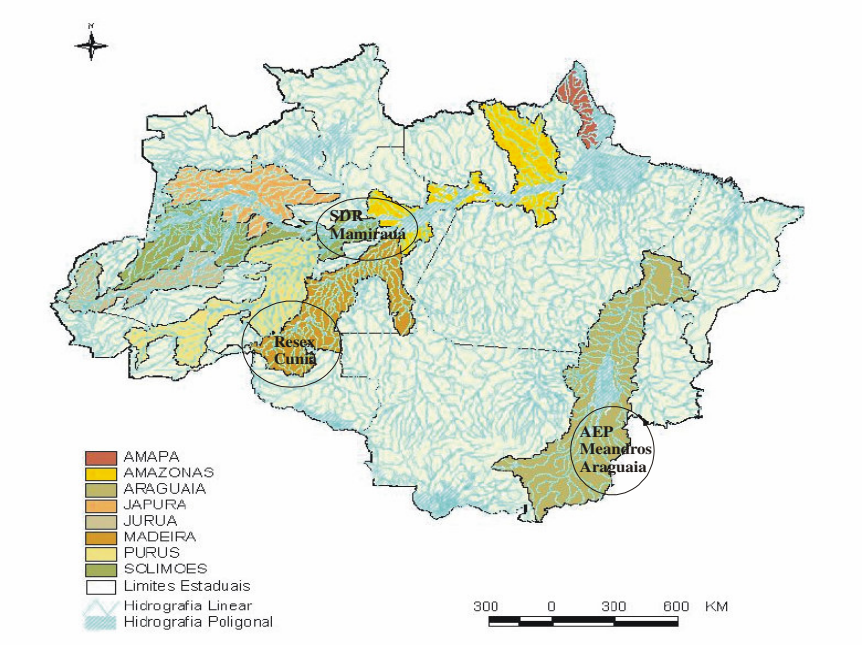

Figure 2. Map of the watersheds surveyed systematically for black caiman, *Melanosuchus niger*, in the Brazilian Amazon.

2.1.2. Community mobilization and training, and logistics

In response to the conflict with humans, there was a strong social mobilization to discuss how to cope with caimans high densities. There are basically two management choices, one is to see caimans as pest and take measures to control them. The other is to treat caimans as a renewable resource, which can be managed for sustainable use. After intense consultation with all community members, there was a consensus that the latter option would be more appropriate. Therefore, members from different communities were recruited to attend a specific training program, which included environmental data sampling, population monitoring, harvesting and processing techniques, among others activities related to all segments of the value chain.

Simultaneously to the training activities, the government and private sector provided the support to build a slaughter house, to attend the requirements of the Brazilian sanitary authority to process caimans.

2.1.3. Applied biological data

Seven independent surveys were conducted from March 2004 to October 2008, covering 467 km of lakes, igarapés and flooded fields, in which 16,782 caimans were counted. Total counts varied between 78 and 5,642 caimans, resulting in apparent densities varying between 5.1 and 100.4 caimans/km. Most of the variation in counts was explained by the seasonal flood cycles, measured by the Madeira river water gauge (Figure 3). When the water level is <400 cm, caimans congregate in preferential sites, where apparent densities reach their highest levels. In some specific sites, they can reach >400 caimans/km, as observed in Lakes Redondo e Libório. During the flooded periods, when water level is >500 cm, caimans disperse and the apparent densities reach their lowest values.

Using the log of density and water level, the linear model D=13.52–1.63 WL, where D= apparent density (caiman/km) and WL=water level (cm), explains 87% of the variation in counts ($F_{1,5}$=41.2, r^2=0.87, p=0.001). The residuals of the relationship were used to determine whether temperature had any significant effect on counts, however, no significant relationship was observed ($F_{1,5}$=0.58, p=0.48), neither was observed any non-linear trend based on partial residual analyses. In order to detect any trend in population size, the residuals were plotted against years. The lack of a significant relationship ($F_{1,5}$=0.06, r^2=0.0, p=0.82) suggests that the index of population size has been stable during the study period (Figure 4).

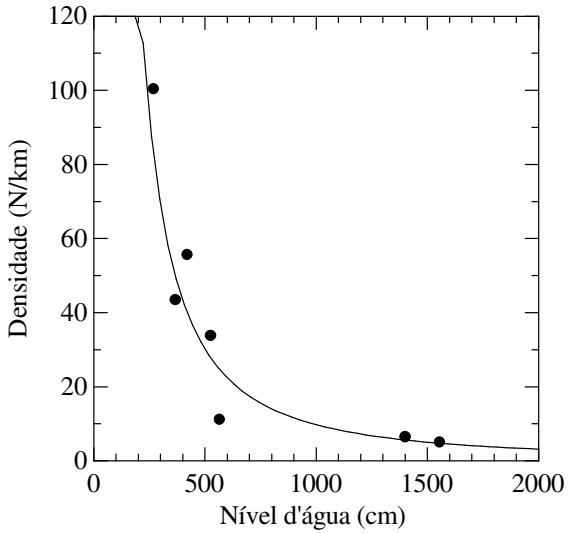

Figure 3. Relationship between water level and apparent densities of caimans in Lake Cuniã Extractive Reserve, Rondônia, Brazil

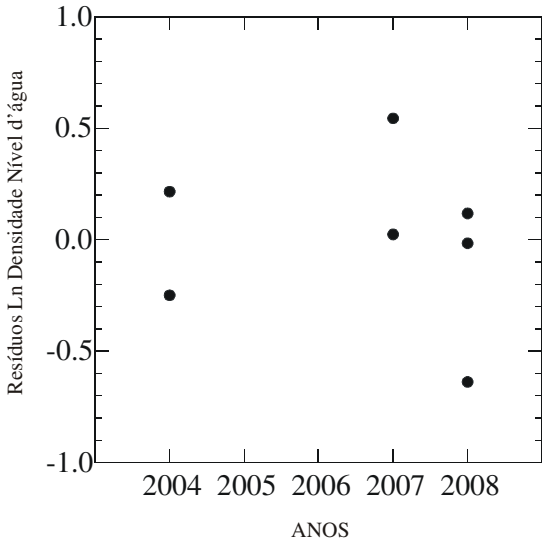

Figure 4. Residuals of the caiman density*water level relationship plotted against study years in the Lake Cuniã Extractive Reserve, Rondônia, Brazil.

In total, 3,775 caimans were approached at distances <5m in order to identify the species. As shown in Figure 5, *M. niger* is the predominant species, with frequency of occurrence varying between 67 and 81% of identified animals. Stock specific composition has been stable during the study period (Kruskal=0.86, df=2, p=0.65).

Population size structure was estimated based on direct sighting of 2,128 and 627 individuals of *M. niger* and *C. crocodilus*, respectively, which were allocated to three

ontogenetic stages defined as juveniles, young-adult and adult. The high percentage of juveniles of both species indicates high recruitment rates. Size structure of *M. niger* has not changed over the study period (kruskal=5.4, df=2, p=0.07).

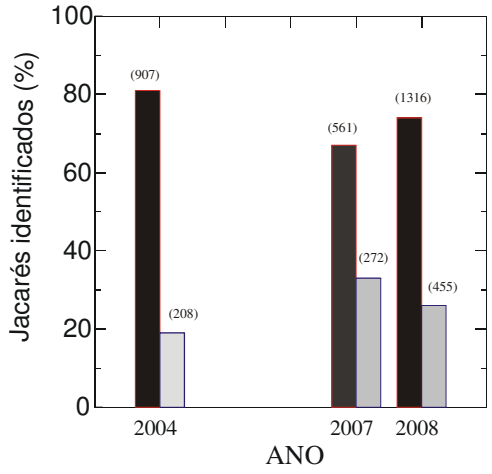

Figure 5. Specific composition of natural stocks of caimans in the Lake Cuniã Extractive Reserve, Rondônia, Brazil. ■ *Melanosuchus niger*, □ *Caiman crocodilus*

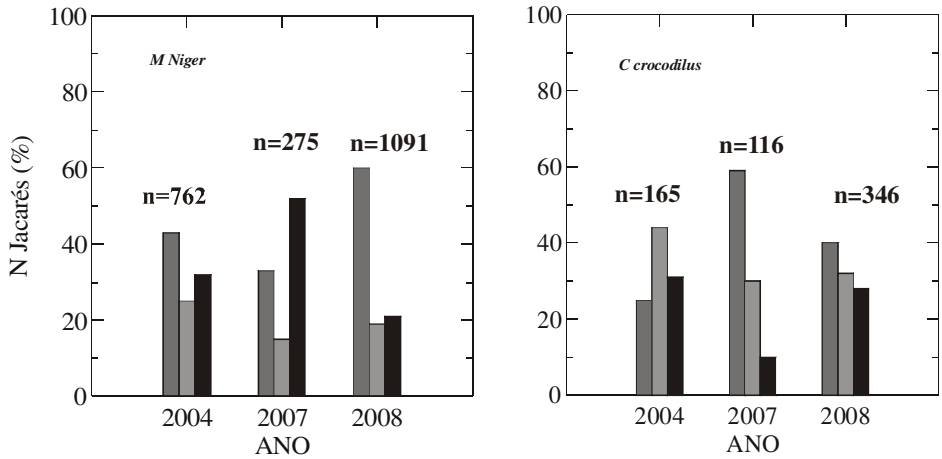

Figure 6. Size structure of natural populations of *M. niger* e *C. crocodilus* in the Lake Cuniã Extractive Reserve, Rondônia, Brazil. Size classes are as follow: *M. niger*: juvenile (■, 40 – 90 cm SVL), young-adult (■, 90 – 130 cm SVL) and adult (■, >130 cm SVL). *C. crocodilus*: (■, 30 - 60 cm SVL), young-adult (■, 60 - 90 cm SVL) and adult (■, >90 cm SVL).

The population sex ratio was defined based on cloacal inspection of 154 and 62 individuals of *M. niger* e *C. crocodilus*, respectively. The data, organized according to the size

classes, are shown in Table 1. As expected, size class IV of both species (adults >130 cm SVL for *M. niger* and >90 cm SVL for *C. crocodilus*) is composed of male. For *M. niger*, the male/female ratio is 1.8 and 1.1 for size classes II and III, respectively, whereas for *C. crocodilus* the ratio is 0.5 and 2.2. for size classes II and III, respectively. At the population level, not considering the size classes, the sex ratios of both species are similar (1.6 for *M. niger* and 1.5 for *C. crocodilus*).

Table 1. Sex ratio defined according to size classes of *Melanosuchus niger* and *Caiman crocodilus* in Lake Cuniã Extractive Reserve, Rondônia, Brazil. See figure 6 to size classes definition.

Melanosuchus niger		**Size classes / Sex**					
Year	**N captured**	**Male**			**Female**		
		II	III	IV	II	III	IV
2008	154	51	32	13	28	28	02

Population	
Male	**Female**
96 (62%)	**58 (38%)**

Caiman crocodilus		**Size classes / Sex**					
Year	**N captured**	**Male**			**Female**		
		II	III	IV	II	III	IV
2007	17	01	06	03	05	02	00
2008	45	08	10	09	13	05	00

Population	
Male	**Female**
62	**37 (60%)**	**25 (40%)**

Nesting ecology

The laying period of M. niger in Lake Cuniã Resex extends for around 30 days, beginning at mid August and ending at mid September. However, in 2008, most of the nests were laid in a 20 days interval, from end of August to mid September, showing that there is a degree of synchronism in population breeding behavior (Figure 7). Additionally, the start of the laying period is associated to fluctuations in water level. As observed in 2008, the first nests are found when water level of Madeira river is <500 cm. Above that level nesting sites are still under water and, therefore, no postures are observed. *M. niger* might use floating mats as nesting sites, however, it is necessary to use other searching methods (p. ex. aerial surveys) to confirm

such hypothesis. The relationship between nesting period and water level is of special practical interest to monitoring the effect of harvesting on natural populations.

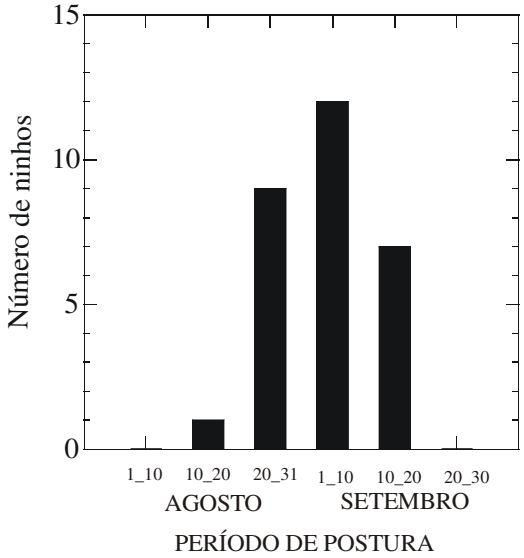

Figure 7. Laying period of *Melanosuchus niger* in Lake Cuniã Extractive Reserve, Rondônia, Brazil.

Females *M. niger* build their nests using litter, Canarana grasses and *Eichornia* as substrates. In Table 2, air and nest temperatures according to nest types are described. Taking air temperature as covariable, nests built in the litter are warmer than those built in Canarana (Ancova, F=10.7, df=1, p=0.00), showing that nesting site and substrates affect hatchlings sex ratio. Based on the proportion of nests that produces females, males and females and males only, hatchling sex ratio was estimated as 45% and 55% males and females, respectively (Figure 8).

Table 2. Air and nest temperature according to the vegetation type of nests of *Melanosuchus niger* in Lake Cuniã Extractive Reserve, Rondônia, Brazil.

Year	Vegetation type		Nest temperature (^{o}C)		Air temperature (^{o}C)	
		n	x±SE	min-max	x±SE	min-max
2007	Canarana	5	30.9±0.5	29.5-32.3	33.7±1.3	30.9-38.2
	Folhiço	10	31.2±0.5	27.8-33.3	29.1±1.2	24.3-34.4
2008	Canarana	17	29.6±0.4	26.2-31.8	28.9±0.7	23.6-33.9
	Folhiço	30	31.0±0.2	28.7-33.0	29.8±0.5	23.6-35.3
	Capim	01	26.2	-	30.1	-
	Eichornia	02	31.7±1.4	30.3-33.2	31.2±0.4	30.8-31.7

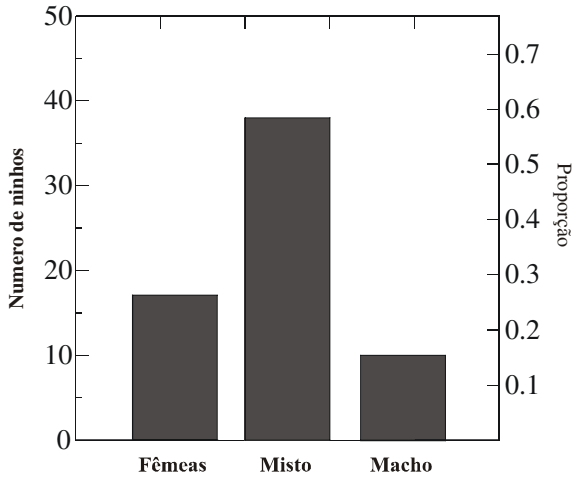

Figure 8. Number and proportion of nests that hatch females only (<30 °C), mix sex ratio (30-32 °C) and males only (>32 °C) of *Melanosuchus niger* observed in 2007 e 2008, in Lake Cuniã Extractive Reserve, Rondônia, Brazil.

In 2008, the search for nests covered an area of about 5,000 ha, where 71 nests were found, resulting an overall density of 0.014 nest/ha (Figure 9). The relationship between cumulative search effort and the number of nests stabilized around 170 hrs of search, whereas total cumulative searching time reached >200 hrs. The definition of an index of nest production, using a standard methodology which can be replicate over the years, is of high practical value, and can be used as an indicator of biological sustainability of the management plan.

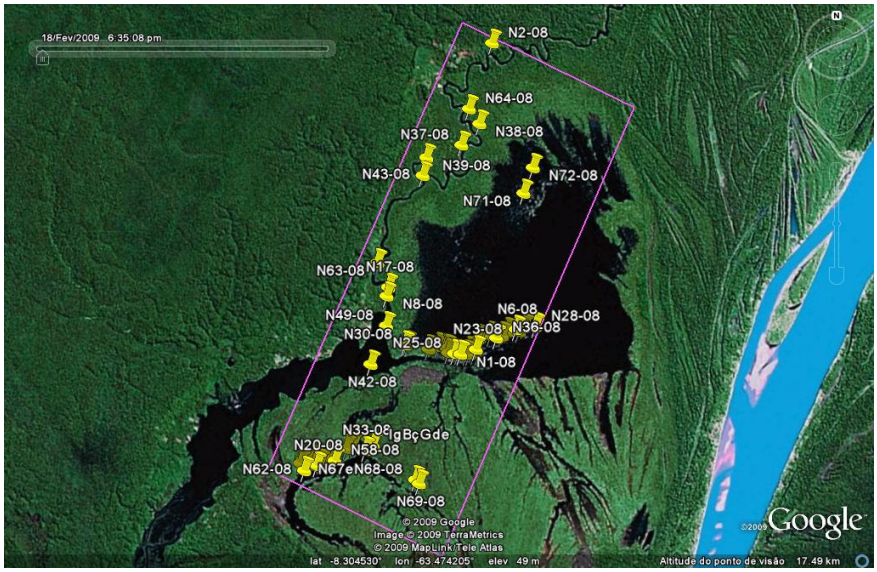

Figure 9. Area of study of the reproductive biology of *Melanosuchus niger* and the location of nests in Lake Cuniã Extractive Reserve, Rondônia, Brazil.

2.1.4. Harvest quotas

The main habitat type used by caimans in Lake Cuniã Resex is the floodplains, which sums 18,000 ha, representing about 30% of the reserve. There are other suitable areas for caimans, including those at the Ecological Station, however, the harvest is focused only at the floodplains, whereas the remaining are kept as buffer area, free of harvest.

The index of caiman population size in the floodplains, calculated based on apparent densities, is estimated in 36,000 caimans. Considering 10% year productivity, the annual harvest quota for the Lake Cuniã Resex is 3,600 caimans. However, as stated by the current Brazilian regulation (see Topic xxx), annual quotas are defined as 10% of the individuals direct sighted in spot-light surveys. Also, due to logistic constraints, the deliberate option has been to start with a more conservative quota, and as the management plan evolves, adaptive management techniques can be used to fine tune harvest quotas yearly.

2.2. Meandros do Araguaia Environmental Protected Area

2.2.1. Preamble

Environmental Protected Areas (EPAs) are included in the category of sustainable use reserves, according to the Brazilian System of Conservation Units (SNUC 2000). Meandros do Araguaia EPA is located in the mid Araguaia river basin, with an area of 357,126 ha. In its mid course, the Araguaia river is marked by a sinuous, meandered shape, forming a number of oxbow lakes which support a rich biodiversity, with high conservation priority. The area is characterized by two distinct seasons, a cool dry winter (April to September) and a hot humid summer (October to March). According to the Koppen system the climate is classified as AW type. The main vegetation types are savanna, seasonal flooded fields and semidecidual forest. The area is of particular scientific interest because it represents the south limit of *Melanosuchus niger* distribution range. It is worth noting that most of the studies on crocodilians in the Brazilian Amazon have been carried on the central-north part of the species range (Da Silveira *et al* 1997; Rebêlo 2001; Rebêlo & Lugli 2001; Mendonça 2006; Ruffeil 2004; de Thoisy *et al* 2006; Da Silveira *et al* 2008).

2.2.2. Population data

From October 2004 to October 2008, 280 km of aquatic environment were surveyed for caimans, during seven independent field trips. The number of direct sighted caimans was 6,716, whereas apparent densities ranged from 1.2 to 65 caimans/km. Most of the variation is explained by changes in water level, measured by the water gauge installed at Luis Alves, in the Araguaia river (Figure 10).

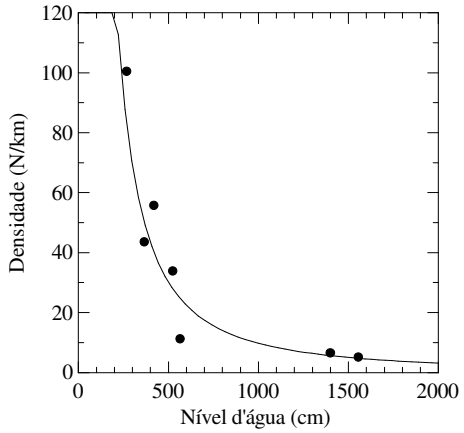

Figure 10. Relationship between water level and apparent densities of caimans in Meandros do Araguaia EPA, Brazil.

Using the log of density and water level, the linear model D=17.96–2.53 WL, where D= apparent density (caiman/km) and WL=water level (cm), explains 79% of the variation in counts ($F_{1,5}$=23.9, r^2=0.79, p=0.001). In order to detect any trend in population size, the residuals of the relationship were plotted against years. The lack of a significant relationship ($F_{1,5}$=0.10, r^2=0.0, p=0.77) suggests that the index of population size has been stable during the study period (Figure 11). However, there signs that the frequency of *M. niger* is increasing in relation to *C.crocodilus*. During the surveys, 2,146 caimans were identified, of which 1,316 were *C. crocodilus* and the remaining 830 were *M. niger*. *C. crocodilus* is the dominant species, but long term monitoring will show whether or not species specific composition is changing (Figure 12).

The population size structure was estimated based on a sample of 6,176 caimans, of which 288 were capture for sex determination, biometric and mark-recapture studies (Figure 13). Populations of both species were represented by individuals of all size classes, indicating

vigorous populations in the area. Species sex ratios, according to the size classes, are presented in Table 3. The sex ratios of both species are quite similar. For *M. niger* and *C. crocodilus* they are 2.8 and 2.2. males to females, respectively.

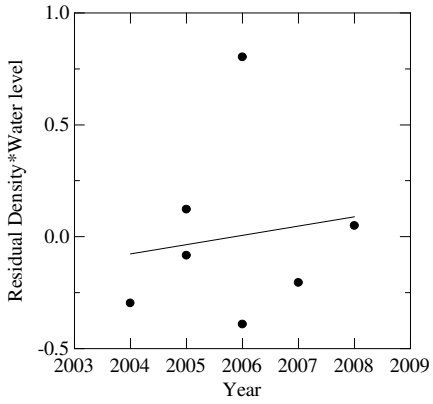

Figure 11. Residuals of the caiman density*water level relationship plotted against study years in Meandros do Araguaia EPA, Brazil.

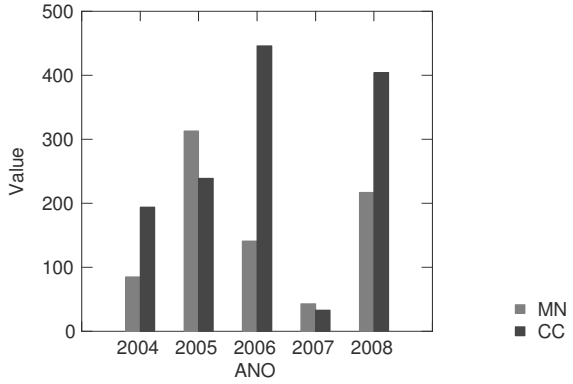

Figure 12. Species specific composition of natural stocks of caimans in Meandros do Araguaia EPA, Brazil. □ *Melanosuchus niger*, ■ *Caiman crocodilus*

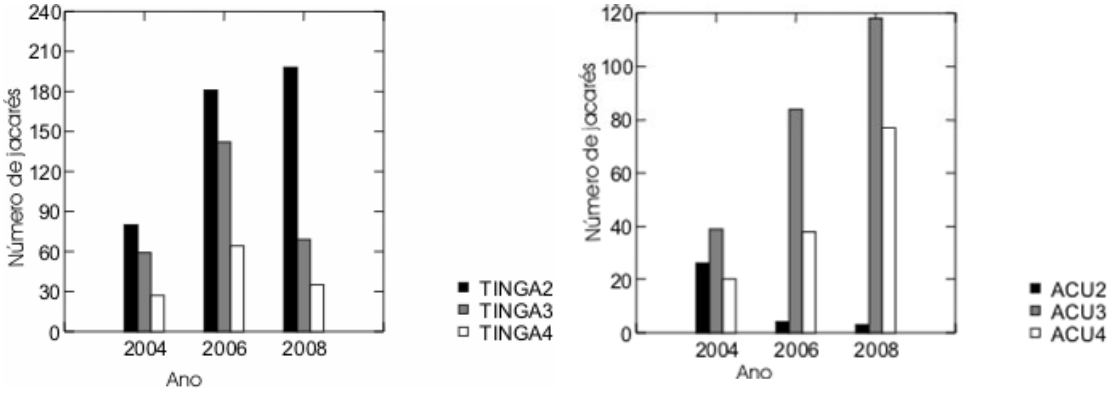

Figure 13. Size structure of natural populations of *M. niger* e *C. crocodilus* in Meandros do Araguais EPA, Brazil. Size classes are as described in Figure 6.

Table 1. Sex ratio defined according to size classes of *Melanosuchus niger* and *Caiman crocodilus* in Meandros do Araguaia EPA, Brazil. See Figure 6 to size classes definition.

Melanosuchus niger				**Size classes / sex**			
Year	**N**		**Male**			**Female**	
	captured	**2**	**3**	**4**	**2**	**3**	**4**
2004	15	05	03	02	01	02	02
2005	17	06	02	05	02	01	00
2006	15	02	06	04	01	01	02
2007	35	05	02	18	06	02	02
2008	21	05	03	07	02	00	03

	Population	
	Male	**Female**
103	**76 (74%)**	**27 (26%)**

Caiman crocodilus				**Size classes / sex**			
Year	**N**		**Male**			**Female**	
	captured	**2**	**3**	**4**	**2**	**3**	**4**
2004	09	01	01	03	02	02	00
2005	26	01	07	11	02	05	00
2006	40	05	06	17	04	08	00
2007	35	06	07	10	09	03	00
2008	11	03	01	04	02	01	00

	Population	
	Male	**Female**
121	**83 (69%)**	**38 (31%)**

2.2.3. Black caiman nesting ecology

Nesting monitoring started in 2004, with searches conducted from October to December. Overall (from 2004 to 2008), 22 nests were found, all located in oxbow lakes which have no

direct connection to the main river channel, and with dense community of aquatic macrophytes. Females used mainly grasses (48% herbaceous vegetation) or litter (52%) to build their nests.

Nest chamber temperature and humidity and nest dimensions were taken from 10 nests. Nest temperature varied from 29.5 to 33.8 ºC (X = 32,0 ± 1,3), whereas humidity varied from 63 to 99% (X = 81,7 ± 14,4%). Nest height and width ranged from 28 to 69 cm (X=43,8 ±11 cm), and from 28 to 215 cm (X =168,1 ± 26,9), respectively. Of the 22 nests, five were predated, probably by *Tupinambis tequixin*, which was seen close to the nests several times. Clutch sizes were obtained from the remaining 17 nests and egg measurements were taken from 90 eggs. Clutch size varied from 13 to 38 (X = 30,5 ± 6,0). Egg length, width and mass varied, respectively, from 77 to 100 mm (X=90,3±4,9 mm), 42 to 58 mm (X=50,5±3,7 mm) and 123,1 to 163,9 g (X=141,8+11,0 g).

2.2.4. Management and harvest quotas

The studies on crocodilian biology in Meandros do Araguaia EPA will continue as part of the research project develop by RAN and no harvest quotas are expected for the area.

Part of the EPA is open to ecotourism, receiving a large number of visits yearly. As part of a specific project on environmental education, crocodilians are used as a reference group to develop educational activities aiming at informing the general public about the ecological importance of crocodilians and their natural habitats.

2.3. Mamirauá Sustainable Development Reserve

2.3.1. Preamble

The Mamirauá SDR is one of the largest sustainable use reserve of the state of Amazonas, with an area of 1,124,000 ha. Its focal area is located at the Solimões and Japurá river basins, where most of the studies on crocodilian biology have been conducted. The pioneer research developed by Bill Magnusson and his students from the early-mid 1980s turned the Mamirauá reserve one of the best known areas for Amazonian crocodilian biology. Actually, such initiative supported by the Federal and State governments, including the Mamirauá Institute for Sustainable Development (IDSM), open opportunity for a number of consecutive studies, which set the biological and socioeconomic basis for the current management plan.

2.3.2. Population data

The potential for sustainable harvest of *M. niger* was firstly identified by Da Silveira in the late 1990s, who described a marked increase in population trend in Mamirauá Reserve (Da Silveira 2001). In five years of study, Da Silveira showed that the number of caimans increased 580 %, changing from 556 individuals observed in 1994 to 3,789 in 1998. The relative proportion of black caimans in relation to spectacle caimans also changed from 38 % in 1994 to 82 % in 1998. Another indication of population growth in Mamirauá was the number of nesting females, which on one lake increased from 1 in 1996 to 22 in 1999.

More recently, a very positive initiative was taken by IDSM researchers who provided a webpage in which the Institute presents the harvest project, reports and monitoring data, licenses and other pertinent information related to the Mamirauá caiman project. For further information refer to the webpage http://www.mamiraua.org.br/pagina.php?cod=186. Such initiative is especially important to confer transparency and to keep observers informed on the development of the management plan. As demonstrated based on data obtained in 2008, crocodilian populations in Mamirauá are vigorous, showing high densities in different parts of the reserve. *M. niger* is the predominant species and the number of nesting females are also high.

2.3.3. Management and harvest quotas

As mentioned above, the biological basis to subsidize a proposal to manage caimans for sustainable use in Mamirauá was defined in the late 1990s. However, there was no legal support to start a harvesting project. In order to move forward with the project, in 2003, the Ministry of environment (IBAMA) advised by Brazilian specialists removed *M. niger* from the national list of endangered species. At the same time, RAN and the Amazonas State Government submitted a joint proposal to start the first legal harvest experiment in Mamirauá (RAN/IBAMA, process n^0 02010.005889/2003-89). The formal permit was issued based on Law 9.985 07/18/2000 and the Decree 4.314 08/22/2002, which regulate nationally the establishment and management of protected areas (SNUC – National System of Conservation Units). Such regulation opened the opportunity to develop commercial harvesting plans in Sustainable Use Reserves, such as Sustainable Development Reserves and Extractive Reserves.

The first harvest quota in Mamirauá was issued in November 2004, followed by two others issued in 2006 and 2008. However, these were considered pilot experiments, small-scale harvest aiming at adjusting a series of legal procedures required by both State and Federal

governments, including the Brazilian Sanitary Authority. In sum, 502 *M. niger* were harvested in Mamirauá.

3. Current regulations and control

As described in Brazil (2007), there are distinct mechanisms to monitor and control caiman harvest and trade, both domestically and internationally. For instance, all CITES regulations are already applied in Brazil, including the international tag system, according to CITES Resolution Conf. 11.12, as well as all the specific regulations for crocodilian trade and management. The Ministry of Agriculture and the State Sanitary Authority have strict measures to control meat domestic trade and exports. It's worth mentioning that black caimans have to be caught alive to be taken to a proper slaughter house for processing, thus representing another important control measure. There are other government agencies that play an important role in controlling trade, particularly at the border with neighbour countries. These include the Federal Police, the State Police at each respective Amazonian State and the Forestry Police, which are also effective to control domestic trade.

Additionally to the measures already mentioned, one of the most effective mechanisms to control and regulate wildlife management is training and educating stakeholders. The establishment of a system of plausible rules and regulations, defining the procedures clearly are also essential to foster the management program.

As part of the Program for Conservation Biology and Management of Brazilian Crocodilians developed by RAN as well as other initiatives provided by Amazon specialists, local communities have been trained and equipped to apply a set of standard methodologies, which include habitat and population monitoring. Additionally, efforts have been taken to improve primary and secondary processing and manufacturing facilities and to develop communication and marketing strategies, which also involve training and personnel qualifications.

Brazilian national regulations are highly conservative and protectionist, underpinning a strong conservation protection ethic. Accordingly, a specific normative has been developed to attend the commercial harvesting of caimans in sustainable use reserves as described in the National System for Conservation Units (SNUC). The process of developing such normative involved several steps. Initially, the proposal was developed by RAN, which submitted the first draft to public consultation on the internet. It was also sent to the Brazilian Crocodilian

Specialist Group and CSG/IUCN expertises to comment and add their suggestion to improve the proposal. The final version was finally elaborated during two days of intense discussions in a workshop organized by RAN, as part of the Brazilian Congress of Herpetology, in July 2009. The normative is now ready to be published, and the expected data is the first semester of 2010.

In summary, in order to join the caiman management program reserves have to register in a national database - Cadastro Técnico Federal, controlled by IBAMA. To obtain an environmental license issued by ICMBio, the following data are required: i) habitat description based on satellite image interpretation, ii) water level, temperature and rainfall recording, iii) standard geo-referenced spotlight surveys estimating population size structure and sex ratio, iv) nesting ecology, v) quota definition and catch-per-unit effort techniques, and vi) socioeconomic indicators and description of the selling points. In order to renew the license, regular evaluations and systematic reports must be provided, which should attend both domestic and international observers and ensure transparency to the programme. Additional information about the normative is available at RAN/ICMBio website (icmbio.gov.br).

Complementarily to the harvesting program developed in sustainable use conservation units, farming and ranching of *M. niger* is regulated under IBAMA normative n^0 169, published early 2008. For ranching, the same set of procedures and data described above are requested, and instead of adults, a proportion of the expected nest production is allowed to be harvested. There are presently no proposals for farming or ranching for black caimans in Brazil.

4. Future directions and perspectives

The development of a new value chain based on products of the Amazon sociobiodiversity is not a trivial task. It requires a number of articulate measures in order to conciliate biological and socioeconomic goals. These include developments in research and technology, local community organization, qualified technicians and labors, mechanisms of financing different segments of the value chain and incentive to public and private investors and entrepreneurs, logistic support, among others. This is a challenge when working in a vast ecosystem such as the Brazilian Amazon.

Despite the difficulties and constraints responsible for slowing the Brazilian harvest program, significant results have been achieved in the last 10 years. For instance, there is a solid biological background which allowed the development of a plausible set of legal procedures.

The normative developed recently with the contribution of stakeholders is considered a bench mark to the program development. Clear rules and procedures set by the government are essential to bring new public and private investors and entrepreneurs, which ultimately foster the program development. Therefore, there are great perspectives for the coming years, particularly, in terms of consolidating the research and development (R&D) approach. The Mamirauá and Lake Cunã projects will continue following the current directions, but searching for new developments in training and education, and mechanisms to improve products quality and marketing strategies. There are also reliable socio and biological indicators to monitor the program success. Likewise, in Meandros do Araguaia EPA the monitoring program will continue, and efforts will be made to expand the study sites to other sustainable use and preserve units. In this respect, the new Institute Chico Mendes for Biodiversity Conservation (ICMBio), which was created in 2007 to deal exclusively with the Brazilian federal conservation units, should play a key role to developing the caiman monitoring program.

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